FIMS and FOUP

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Clean Manufacturing: A Parametric Study of Airflow & Airborne Particle Performance for a 300-mm Loadport, Haifeng Zhang Ph.D., Sameer Abu-Za P.E., August 2003

In this study, airflow and airborne particle tests for a 3OO-mm loadport (IsoPortTM) are per- formed in an ISO per ISO 14644-1 standards, the objectives of these tests are to understand the effects of various factors on th performance of the IsoPort. Such factors include the gap size between the FOUP (Front Open Unified Pod) sl port plate, the FOUPIFIMS (Front-opening Interface Mechanical Standards) door opening speed profile, and t pressure between the enclosure and the ambient environment. It was found that there are two particle source open/close cycle. The first source is the ambient F AB air squeezed out of the space between the FOUP door as the FIMS door advances towards the FOUP door in the docked FOUP position. Depending on the gap size may either exit the system through the gap between the FOUP shell and port plate, or remain in the local area until the FOUP door is opened. In the latter case the contaminated ambient air may end up inside the FOUP a the enclosure as a result of FOUP/FIMS door movement. The second source is caused by ambient air infiltrat through the gap as a result of negative differential pressure created behind the FOUP door during its opening of gap size, FOUP door-opening speed profile, and mini environmental ambient air differential pressure on sy be presented and discussed in this paper.

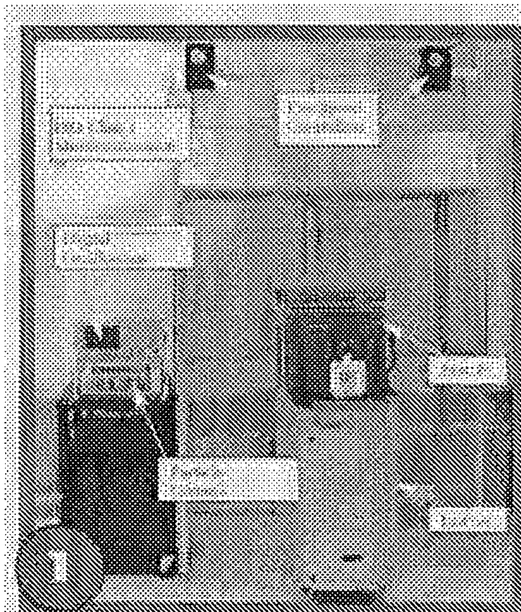


Figure 1: Experimental Setup.

State-of-the-art chip manufacturing requires more stringent airborne particle cleanliness specifications. This is shrinkage in line width feature size. As line width gets smaller, particles of smaller sizes become more detrim good die per wafer. The new ISO 14644-1 Standards therefore require equipment cleanliness certification to t particle size (0.1 micron) than the outdated FED-STD-209E Standards.

Loadports are part of the semiconductor equipment set used for automatic handling of silicon wafer~ through manufacturing cycle. Silicon wafers are isolated inside a sealed plastic enclosure (commonly referred to as SI wafers, FOUP for 300

This paper will focus on a 300-mm loadport (IsoPort). Ille FOUP open/close sequence of events for the IsoPoi placed on the loadport, 2) the FOUP is latched to the advance plate, 3) the FOUP moves forward from its HOI to the port plate, 4), before the FOUP reaches the port plate (dock) position, the FIMS door moves backward a short distance, 5) the FIMS door moves forward towards the docked FO UP and the FIMS door latches to th FOUP door is opened, and the combined FOUPIFIMS door move into the minienvironnient enclosure, 7) the F move downward to STAGE position, 8) the FOUPIFIMS doors move towards docked FOUP, 9) FOUP is clos

back to HOME position. The various steps have significant effects on the overall cleanliness of the IsoPort. Tł is the FOW door opening and the FOUPFIMS doors movement into the enclosure. In this paper, several para the cleanliness of the IsoPort will be presented and discussed.

Experimental Setup

Figure 1 shows the experimental setup used throughout the study. It consists of an IsoPort and an ISO Class The ambient surroundingthe setup is ISO Class 7-8. The following equipment are used:

* Met One A2100B Airborne Particle Counter (calibratedon 9/18/02)

* ShortridgeADM-860 Air Data Multimeter (calibrated on lus/oz)

* ASHCROFT Pressure Sensor (0.1inch-water)

* Tektronk TDS3032 Digital Phosphor Oscilloscope

Air-borne particles are measured inside the enclosure locally at the gap between the FOrfP shell and port plał inating from the space (ambient air) between the FOUP and FIMS doors, or particles brought in through the g shell and pod plate should be detected at the location shown in Figure 2a. Similar behavior will be seen if the placed at the opposite side of the port plate, or at the top or bottom sides, since the air "squeezing" effect is tł directions.

In order to understand the airflow behavior behind the FOUP door during its opening stroke and at the gap be shell and the port plate, a highly sensitive, fast acting differential pressure sensor is used (ASHCROm) which inches-H20. The differential pressure output of the sensor is displayed on a Tektronk TDS 3032 Digital Phosp Should a negative differential pressure signal be observed at the gap, it would indicate that particle laden amł into the enclosure through the gap. On the other hand, a positive differential pressure signal would indicate th flowing from the enclosure to the ambient through the gap. Figure 2b shows the two differential pressure sens

Several different pressure output signals for various conditions are recorded and analyzed. Table 1 is a sumn studied. Case 1 is using a two-step doore opening speed profile with a small initial door opening accelerator. two step door opening speed profile with a nominal acceleration setting. The gap between FOUP shell and th 0.5mm for Case 3 and is 2mm for all other cases. Case 4 is using a one-step door opening with the default ac 5.0 inch/sec2. For all cases studied, the door closing stroke is a one-step speed profile at an acceleration of 5

The speed profiles of the FOUP/FIMS doors used in each case are shown in Figure(3).

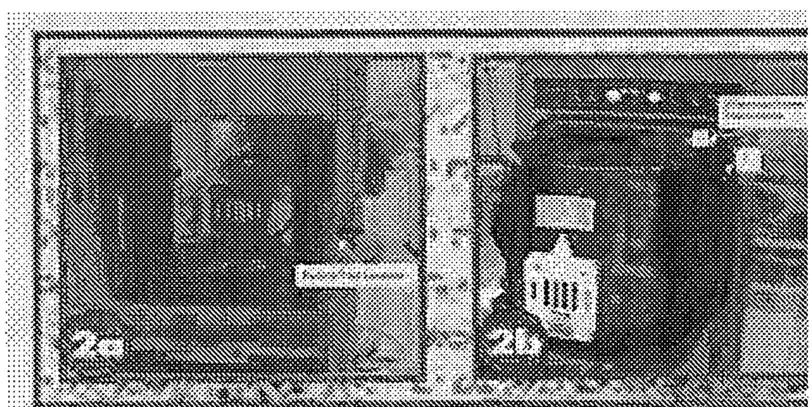


Figure 2a: Airborne particle test location. Figure 2b: Differential pressure test locations.

Table 1

Case	Door Opening	Acceleration (inch/sec^2)	Distance of Switching (inch)	Gap (mm)
1	two-step	0.25 for 1st 2.5 for 2nd	0.25	2
2	two-step	1.0 for 1st 2.5 for 2nd	0.25	2
3	two-step	1.0 for 1st 2.5 for 2nd	0.25	0.5
4	one-step	2.5	---	2

Table 1: Cases studied.

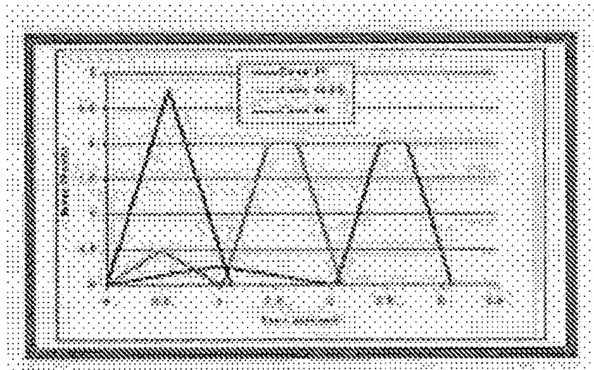


Figure 3: FOUP / FIMS doors opening speed profiles for various cases.

Results and Discussion

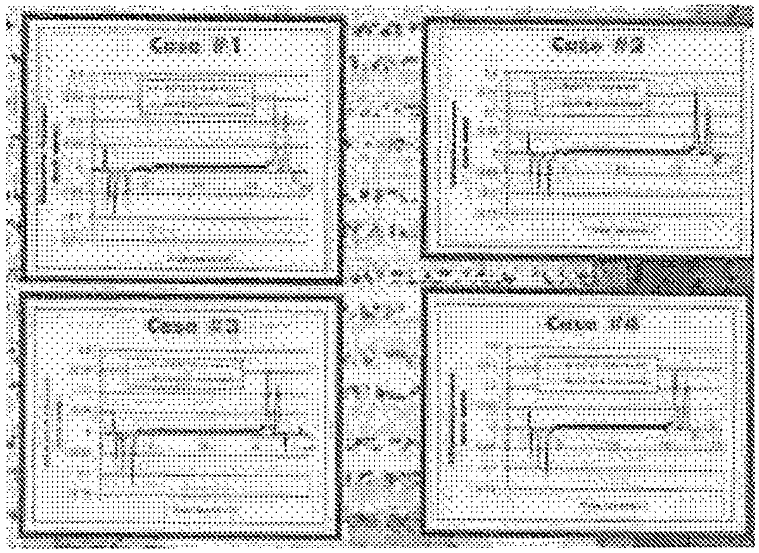
Figure 4, Cases 1-4, display the differential pressure variation inside the FOUP (Eocation 1) during a full IsoP advance, SMART port door motion, FOUP door-opening, downward motion, upward motion, FOUP door-closi HOME position). At the instant of FOUP door-opening, a sharp negative differential pressure is observed insic Conversely, when closing the FOUP a positive differential pressure is observed at the same location. Addition negative differential pressure peaks during the door opening and two positive peaks during the door-closing s The value of the negative differential pressure peak (>O.1 inch-water) is about one order of magnitude greate pressure (0.01 inch-water) between the minienvironment and the ambient. The maximum negative pressure fı the FOUP door) during the door-opening stroke for the various cases is shown in Figure 5. The magnitude of pres- sure behind the FOUP door for a two-step speed profile is less than that for a one-step profile. Figure 5 minimum negative differential pressure behind the FOUP door corresponds to case #3, which is the lowest dc acceleration case. The minienvironment differential pressure does not have significant effect on the differentiε behind the FOUP door during a full IsoPort cycle.

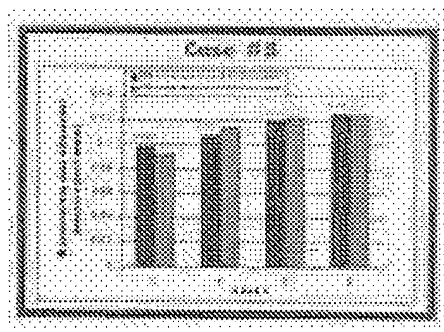
Variations of differential pressure versus time at the gap between the FOUP shell and port plate (location 2) a 6a-6d. The differential pressure decreases at the gap during the door-opening stroke. As shown before, the n formed at the instant of door opening. The negative pressure may cause ambient air to enter the FOUP and e gap. For Case #1 and Case #2, the differential pressure dips twice during the two-step door opening as show the two-step door-opening speed profile. On the other hand, for a one-step door-opening speed profile (case ı pressure dips only once as shown in Figure 6d. As the gap gets smaller (0.5 mm for case #3), the resistance much higher, hence there is no apparent differential pressure change as shown in Figure 6c. Differential pres location 2 are more when one-step rather than two-step door-opening speed profile is used.

At higher differential pressure (0.01inch-water) between minienvironment and ambient, no negative differentia detected at the gap when a two-step door opening speed profile is used, as shown in Case %a. For the one-s profile, a short duration negative differential pressure is observed as shown in Case #6c. When the differentia the minienvironment and the ambi- ent is 0.005 inch-water, short duration negative differential pressure is obs two-step door-opening cycle Therefore, at higher differential pressure between the minienvironment and the a ambient air will be drawn into the minienvironment through the gap.

Airbome particle tests were performed at the location shown in Figure 1. Figure 7 shows the average particle micron, under different conditions. FOI Case #3 with a very small gap between the FOUP shell anc the Port p not enter the minienvironment because of the higher airflow resistance caused by 6 smaller gap size. The hig concentration for this case indicates that it has been caused by entrapment of ambient ah between FOUP anc is, when the FIMS door attaches to the FOUP door; the air volume between the two surfaces will be displacec directions. With very small gap, the displaced air may not be adequately
flushed out of from the local area of the gap. When the FOUP door is opened, the negative differential pressu door causes the ambient air to enter the FOUP. With higher minienvironment differential pressure and larger (displaced air will be flushed out of the system. Also, higher minienvironment differential pressure can prevent entering the enclosure during door-opening. Therefore, low particle concentration can be achieved at higher n differential pressure and larger gap. It is also observed that the effect of the door-opening speed profile on pa insignificant at the higher differential pressure, 0.01 inch-water, and 2 mm gap.

Particle per wafer per pass (F") experiments have been performed at two customer sites. The results clearly i mcdi6ed FOUPRIMS doors opening speed profile achieves an order of magnitude better WW results than do speed profile. In addition, more studies are being performed to arrive at an optimized door-opening speed pro achieve the best cleanliness performance, and shorter cycle time.





Conclusions

Differential pressure and airborne particle tests are performed for the IsoPort under different integration condi test results, the following conclusions can be drawn:

* Negative Uerential pressure is observed inside the FOUP behind the FOUP door during the door-opening st

* The magnitude of the negative differential pressure peak is dependent on the door speed profile.

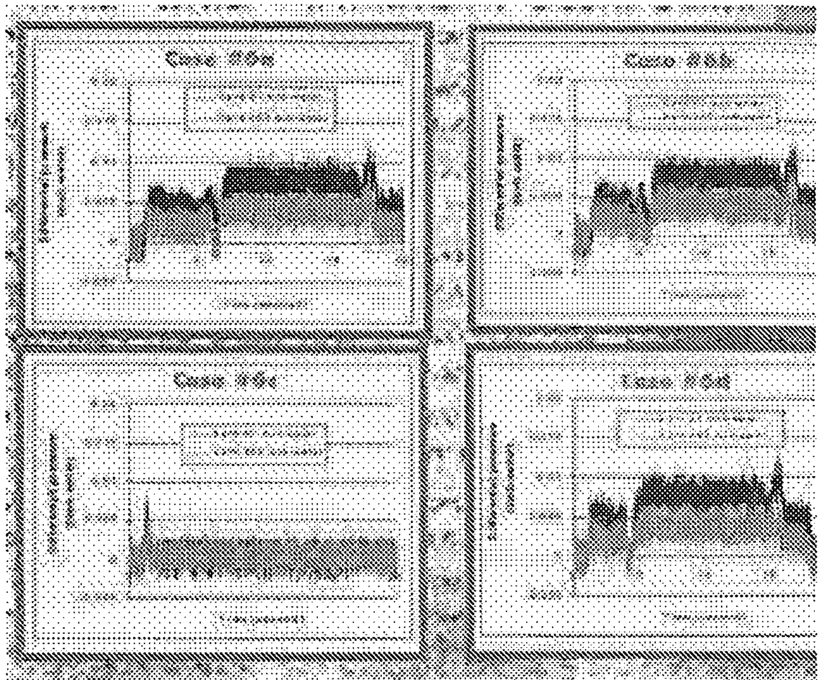
* At low minienvironment differential pressure (0.00sinch- water) and 2 mm FOUP-loadport gap, ambient air n minienvironment through the gap between the FOUP shell and the port plate during the door-opening stroke.

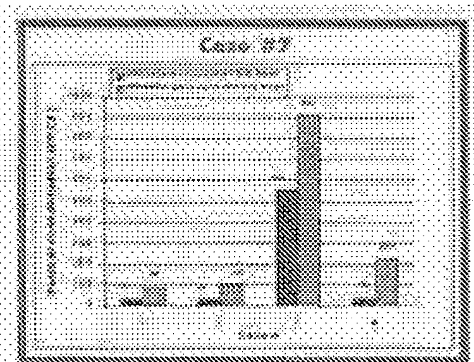
* There are two possible sources of particle contamination from loadport, one is due to ambient air infiltration between the FOUP shell and the port plate. The other is attributable to the air displaced from between the FO during the FIMS door advancement towards the FOUP door.

* Higher minienvironment differential pressure can prevent ambient air from enteringthe enclosure dur- ing the

* Larger gap, between the FOUP shell and the port plate, can allow displaced ambient air (between FOUP an leave the system through the gap.

* Lower airborne particle concentration for the IsoPort can be achieved at higher minienvironment differen- tia water) and larger gap (2 mm).





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Keyword